Experimental Analysis And Different Modeling Approaches For A Stormwater Perlite Filter

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Abstract. Stormwater infiltration is one of the typical techniques used in Best Management Practices (BMPs) for urban stormwater drainage and control. This technique promotes the reduction of runoff discharges and volumes, as well as groundwater recharge. However, there are also some negative impacts associated with infiltration, such as the risk of groundwater contamination and reduction of the infiltration rate through time due to infiltration surface clogging. Both problems can be substantially controlled by reducing the suspended solids (SS) load and concentration before stormwater reaches the infiltration areas.

This paper presents the study of a mixed porous media conformed by expanded perlite and nonwoven needle punched geotextile used for removal suspended solids in urban runoff. In order to understand the behavior of this mixed media, several laboratory procedures were designed to determine the most important variables that characterize the performance of the filter media: SS efficiency removal and filtration rate variation in time. Different expanded perlite granulometries, SS concentrations, and diverse hydraulic and geometric conditions were tested in order to represent the typical conditions under which a stormwater filter would operate. An additional objective is to determine the more effective filter media in terms of removal capacity and maximization of the filtration rate. To determine this, a dimensionless parameter called Global Performance Index (GPI), which couples quality and quantity characteristics, is developed and presented.

The data measured are also used to build two models whose objectives are to represent the performance mathematically of the filter media and to facilitate the design, operation and evaluation of future commercial modular filters. The theory, assumptions, derivation and performance of both models are presented.

The first model is dimensional, which allows the estimation of the removal efficiency and the filtration rate based on dimensionless variables describing the processes. This is a general model able to reproduce the filtration process under diverse conditions. The second is a regression model, which as opposed to the dimensional model, must be calibrated for different conditions. Both models, as well as an empirical model proposed by Urbonas (1999), are compared. The results from each of the models and the comparison of those to the data obtained in the laboratory are presented.

Two main outcomes from this work are identified: (1) the availability of new tools to evaluate and model the performance of a filter media, and (2) the availability of theoretical and empirical basis for the design of modular and standard filters using expanded perlite as the main filter media.

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